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ABSTRACT

Presented is a science activities in energy package which includes 15 activities relating to chemical energy. Activities are simple, concrete experiments for fourth, fifth and sixth grades which illustrate principles and problems relating to energy. Each activity is outlined on a single card which is introduced by a question. A teacher's supplement is included. (SL)

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## SCIENCE ACTIVITIES IN ENERGY

Science Activities in Energy is a series of simple, concrete, revealing experiments that was developed by the American Museum of Atomic Energy especially for fourth, fifth, and sixth graders but can be just as useful in community programs.

The purpose of the series is to illustrate certain principles and problems related to various forms of energy and to their development, use, and conservation.

More important, it is an effort to help you and other teachers involve students directly in exploring intriguing questions—in making discoveries on their own.

You needn't be an expert in science to use this material. In fact, teachers shouldn't be expected to know the "right" answer to every question posed. What's more, many of the activities involve not just science but art, economics, arithmetic, reading, and other skills and disciplines as well—and need not be used in sequence.

Each unit in the series forms a coherent program of instruction on a single topic: solar energy, electricity, conservation, and the like.

Most activities in the series can be completed in the classroom with materials readily available in any community: pots and pans, paper cups, water, salt, thermometers, and cardboard boxes. A few require purchases from local or national suppliers.

Each project is introduced as a question: How much warmer do objects get in the sun than in the shade? What is the best color to paint a house to keep it cool in the summer? Which stores solar energy better—water or rock?

At the outset of an experiment, try to get your students to predict outcomes, even when they have no experience to justify their projections. Urge them to make a guess. They'll become more interested, feel more involved, if they do.

In order to answer each question, a student (or the class as a group) follows instructions on an activity card that lead him or her through a specific experiment.

This kind of direct student participation leads easily to other related questions—some suggested on the activity cards themselves, others generated by the students and their teacher—and to further exploration by the experimenters on their own.

The American Museum of Atomic Energy has purposely used metric measurements throughout the experiments, believing that this would be part of the learning process for many young people and for some adults as well.

Because the activities are outlined on single cards, you can easily photocopy them for distribution or project them on a screen or wall.

As the developers of the series, we are anxious to learn how you and your students use the materials, what variations you develop, and any results you find extraordinary. Please let us know your reactions to the materials, and feel free to ask for more information on any energy-related topic.

## CHEMICAL ENERGY

The dominant source of energy in the United States is fossil fuels—coal, oil, and natural gas. They supplied 18 per cent, 47 per cent, and 28 per cent, respectively, of the United States' energy in 1976. The balance among these sources will undoubtedly change in the years ahead, with wider use of nuclear power, but America's reliance on them will continue for some time to come.

Less than 12 per cent of the coal and oil used in the country goes into manufacturing—of nylon, plastics, etc. Some scientists contend that these energy sources are too limited—too precious—to be wasted on heating, cooling, and electricity, and should instead be devoted almost exclusively to manufacturing. Such a possibility, though tempting, is not realizable in the immediate future simply because the nation's energy needs are so great and because wide use of alternate energy sources (nuclear and solar power, for instance) is still possible.

All fossil fuels are limited. The consensus of most experts is that we have found more than half of the world's oil, and the remaining portion will be exceedingly difficult to locate. Coal, on the other hand, is more readily available, but it poses significant environmental problems (air pollution, ash removal, etc).

In fact, significant problems accompany the use of all of the fossil fuels: locating them and recovering them at affordable costs, and using them in ways that conserve their supply and are not detrimental to the environment.

We are currently recovering less than 80 per cent of the coal and 40 per cent of the petroleum from our mines and wells. But new efforts are under way to increase the yields of these sources—limited though they may ultimately be.

Attempts to reduce waste of these fuels—development of cars giving better mileage and of more efficient home appliances and air-conditioning, for example—are going to be important parts of American life through the remainder of this century.

Activities in this unit on chemical energy focus on comparisons of various fuels, measurements of temperatures generated by each, depletion of resources, and other facets of fossil fuel development and use.

This series, **Science Activities in Energy**, was developed by Oak Ridge Associated Universities under contract from the U.S. Department of Energy, with assistance from teachers and staff from the Lawrence Hall of Science, Berkeley, California. This publication was prepared as an account of work sponsored by the United States Government. Neither the United States nor the U.S. Department of Energy, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

# HOW LONG DOES A "CELL" MADE FROM MAGNESIUM AND BRASS LIGHT A LAMP ?

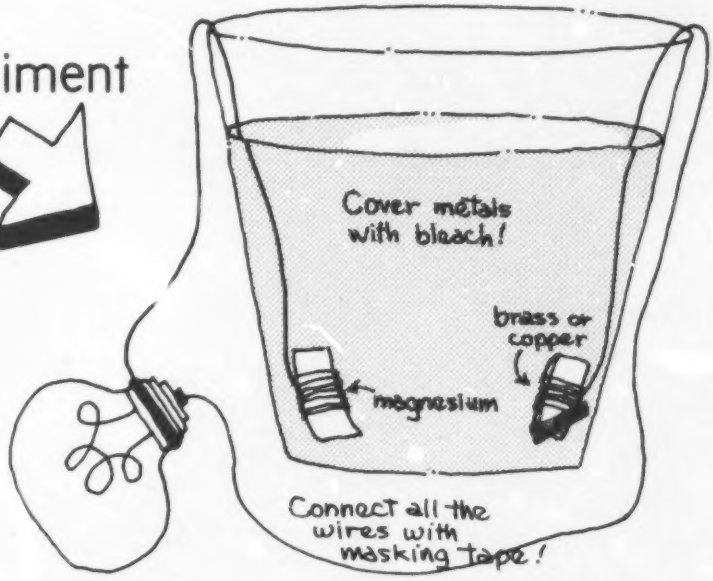
1

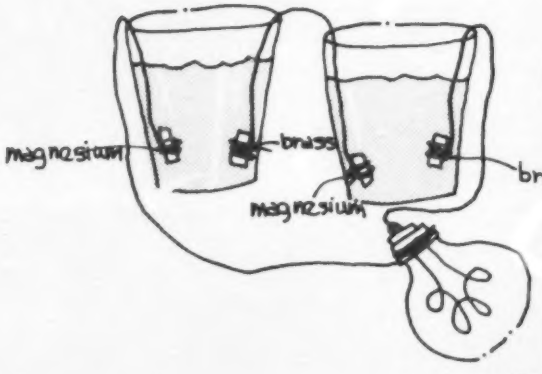
## MATERIALS:

2 cm Magnesium ribbon ← ask a high school chemistry teacher! , timer
1/2 Cup household bleach
Brass or copper metal, any size
Styrofoam cup
1 #48 Lamp (2 volt, 60 ma) ← ma = milliampere; $\frac{1}{1000}$ amp!
Bell wire, masking tape

Set up your experiment like this.

How bright is the lamp ?




Now connect like this, and fill the cells with new bleach. What happens to the light ? What would happen if you hooked up more cells ?

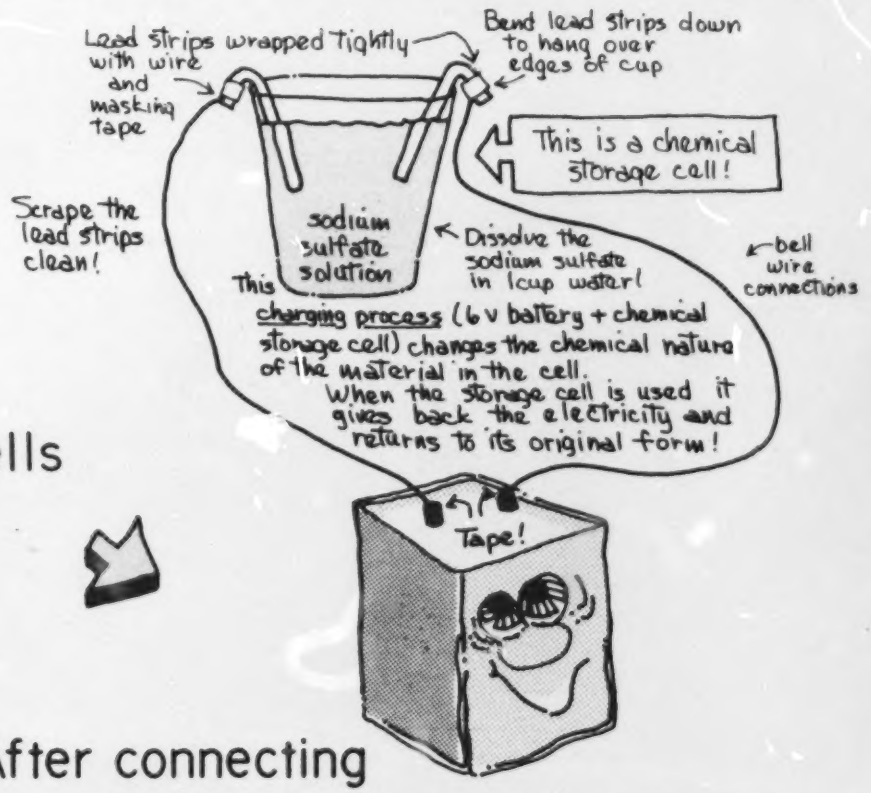
# HOW MUCH ELECTRICITY DO YOU GET BACK WHEN YOU STORE IT IN YOUR STORAGE CELL ?

2

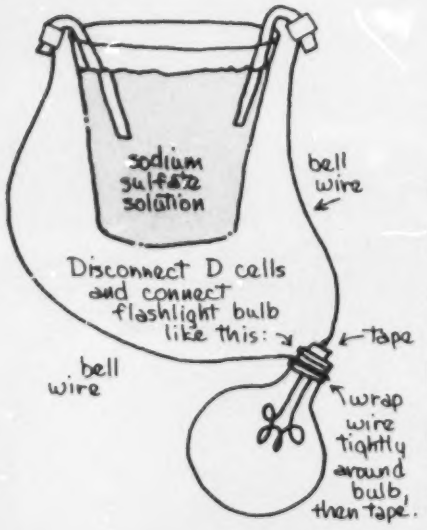
## MATERIALS:

16v Lantern battery ← ask a high school chemistry teacher!
2 Tbsp. sodium sulfate (Glauber's salt)
2 Pieces of lead (approx. 4cm x 8cm) ← any thickness will do...
Styrofoam cup, masking tape, water, timer
Flashlight lamp, bell wire, measuring spoons

Do this first:

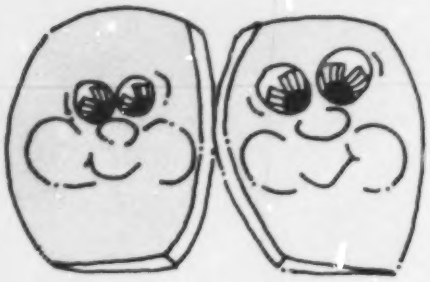

Lead strips wrapped tightly with wire and masking tape
Bend lead strips down to hang over edges of cup
This is a chemical storage cell!
Scrape the lead strips clean!
sodium sulfate solution
Dissolve the sodium sulfate in 1cup water!
bell wire connections
This charging process (6v battery + chemical storage cell) changes the chemical nature of the material in the cell.
When the storage cell is used it gives back the electricity and returns to its original form!
Tape!

Connect the 2 cells like this.

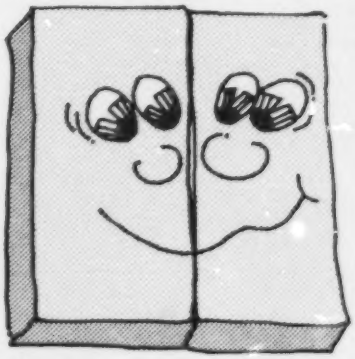

sodium sulfate solution
bell wire
Disconnect D cells and connect flashlight bulb like this:
tape
bell wire
wrap wire tightly around bulb, then tape.

After connecting the cells, bubbles should appear on the lead strips. After 5 minutes remove the dry cell from the circuit, and connect the flashlight lamp. Will the bulb stay lit for 5 minutes?

# OTHER IDEAS TO EXPLORE:



If the lead strips were bigger or thicker, would you be able to store more electricity?



Would your experiment work better if the lead plates were closer together?

If you take your chemical cell apart and put it back together the next day, will it still make your light work?

# WHICH HAS MORE HEAT ENERGY, A OR A ?

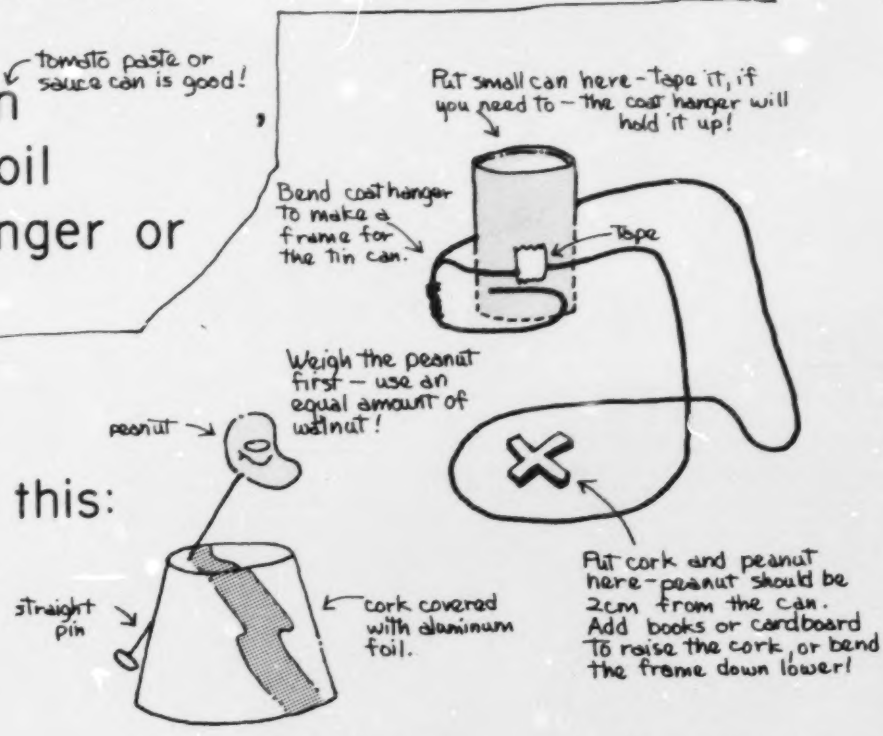
3

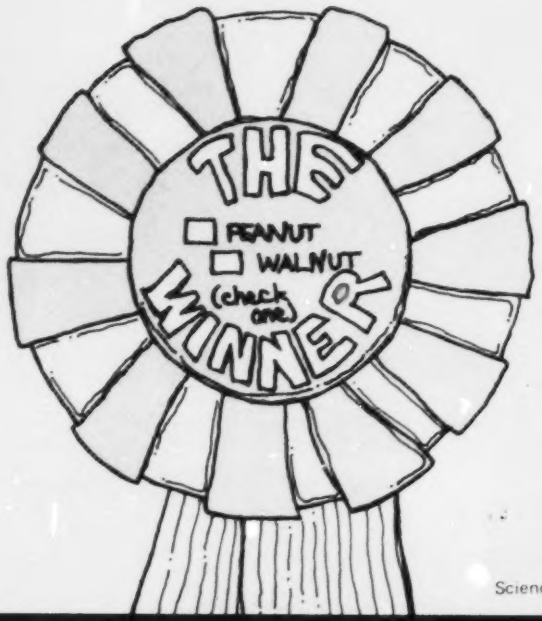
## MATERIALS:

1/2 Shelled peanut, equal amount of walnut
Cork, thermometer
Straight pin
Small tin can (tomato paste or sauce can is good!)
aluminum foil
Wire coathanger or stiff wire

↖ Use postage scale for more accurate results!

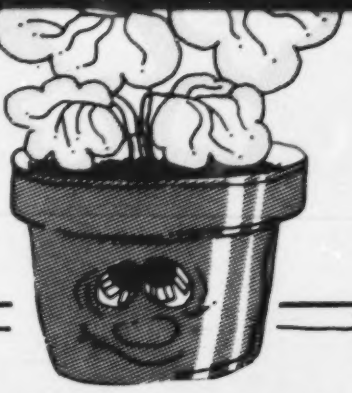
Set up your experiment like this:


Put small can here - tape it, if you need to - the coat hanger will hold it up!
Bend coat hanger to make a frame for the tin can.
Tape
Weigh the peanut first - use an equal amount of walnut!
peanut
straight pin
cork covered with aluminum foil.
Put cork and peanut here - peanut should be 2cm from the can. Add books or cardboard to raise the cork, or bend the frame down lower!




Fill the tin can 3/4 full of cold water. Record the temperature. Set fire to the peanut, and record the water temperature after burning. Now try the walnut. Which raises the water temperature more? (start with cold water again!)

# HOW RAPIDLY DOES A PLANT MAKE STARCH?



4

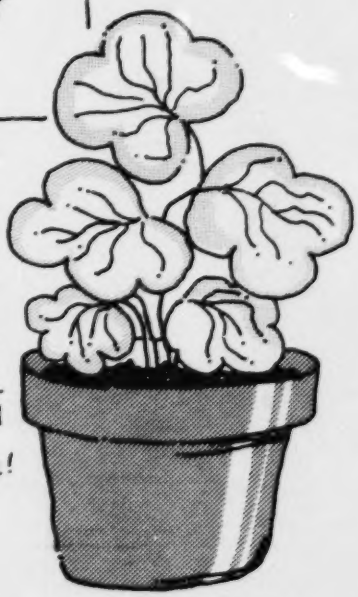
## MATERIALS:

Tincture of iodine, water
Geranium plant
Potato, sugar, graduated cylinder
Black paper, paper clips

a test tube marked in milliliters (ml) – borrow from a high school chemistry lab!

Do this first:

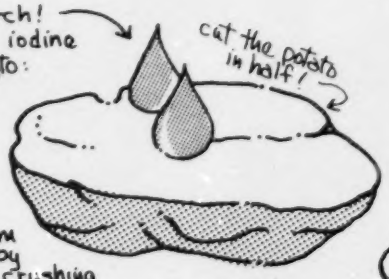
Make an iodine solution by adding 5ml iodine to 45 ml water!



Place the geranium in a dark closet for 2-3 days – the leaves will begin to turn white!

Test the potato for starch! Place a few drops of iodine solution on the potato: if it turns blue it has starch in it!

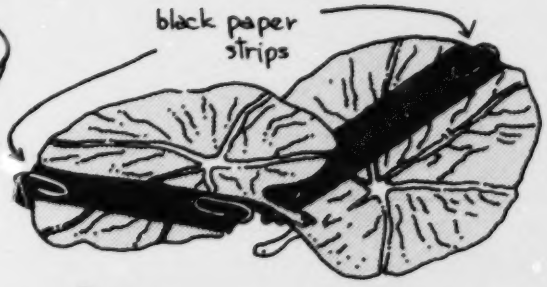
cut the potato in half!



Now test a white leaf from the geranium by crushing it in a small amount of water.

What happens?

Test the sugar. what happens?



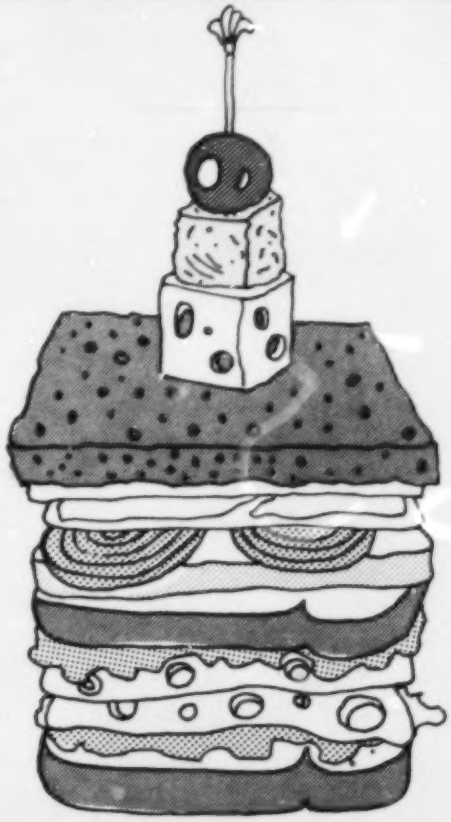

Remove several leaves from the geranium. Cover in places with black paper strips and place in the sun for 2 hours. How long does it take for the leaves to turn green?

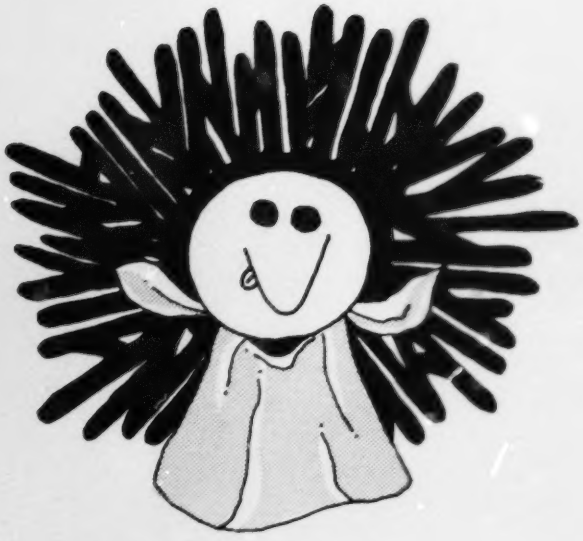
Now test the leaves for starch again!

What happens to the leaf under the black paper? Test it for starch too!

## OTHER IDEAS TO EXPLORE:

Test different foods for starch. Do some plants have more starch than others? Where did the starch come from?





Can you trace your dinner back to the sun?

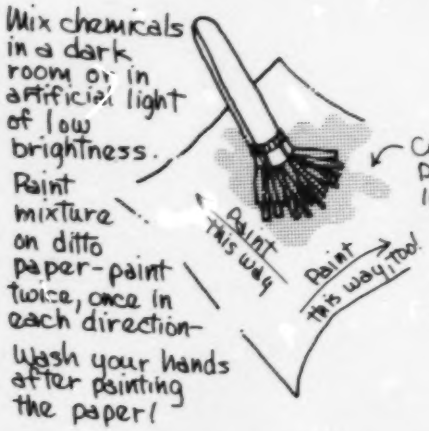
# HOW LONG DO YOU HAVE TO EXPOSE BLUEPRINT PAPER TO MAKE A PICTURE?

5

## MATERIALS:

10 grams Ferric Ammonium Citrate
8 grams Potassium Ferricyanide ← obtain from high school chemistry lab - Teacher should mix solutions! (Makes enough for 30 students)
50 ml Graduated cylinder
Watch, paintbrushes, water, 3 quart jars
Ditto paper (or any non-absorbent paper)

Mix the solution first:

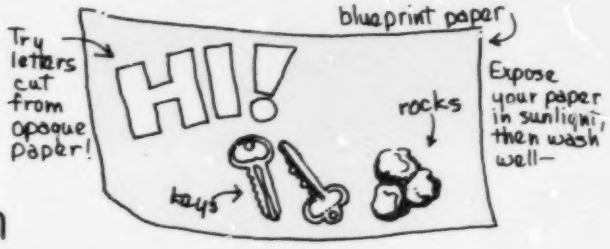

Mix chemicals in a dark room or in artificial light of low brightness.
Paint mixture on ditto paper - paint twice, once in each direction -
Wash your hands after painting the paper!
Coat the paper, then let it dry!
Paint this way
Paint this way, too!

## To make blueprint paper:

Mix equal parts of each solution together, and paint the paper.

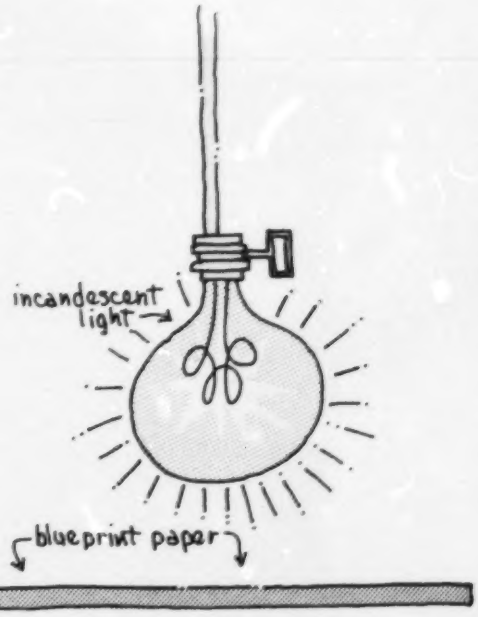
## To make blueprints:

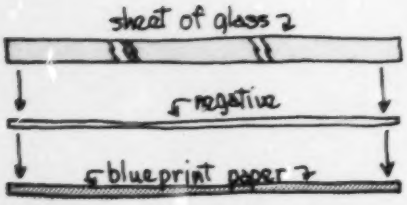
Expose to light - how long does it take to see something happen? Then wash well.



# OTHER IDEAS TO EXPLORE:

Try exposing blueprint paper under incandescent light only and then under fluorescent light. What happens?




Ask your local newspaper office or a printing company for old black and white negatives. Place the negative on the blueprint paper, then put a piece of glass on top to hold it to the paper. Expose to the sun, then wash well and allow to dry.

Try this experiment with color negatives, if available.

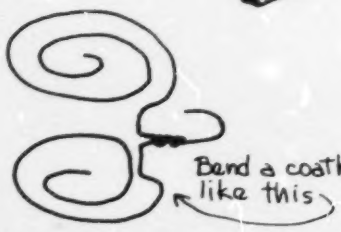
# WHICH HAS MORE ENERGY WOOD OR PARAFFIN?

(derived from petroleum!)

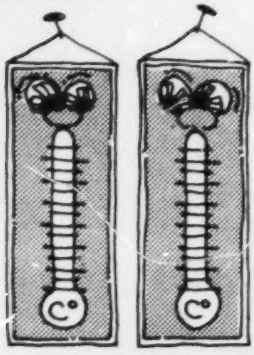
## MATERIALS:

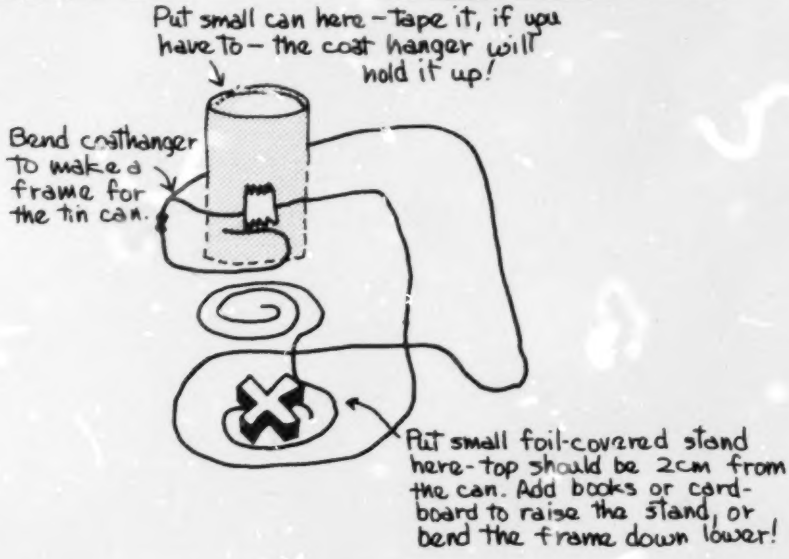
Small tin can (tomato paste or tomato sauce cans are good!), thermometer
Wire coathangers or stiff wire, masking tape
Aluminum foil, birthday candles, small pieces of wood, postage scale (1 oz = 30 grams)

Make 2 stands like this:




and cover the top with aluminum foil. Use this stand to hold the wood and wax!





Put small can here - Tape it, if you have to - the coat hanger will hold it up!
Bend coathanger to make a frame for the tin can.
Put small foil-covered stand here - top should be 2cm from the can. Add books or cardboard to raise the stand, or bend the frame down lower!

Fill the can 3/4 full of cold water. Record the temperature. Ignite 30 grams of wood and record the water temperature again. Try it with 30 grams of wax. Does wood or wax raise the water temperature more?

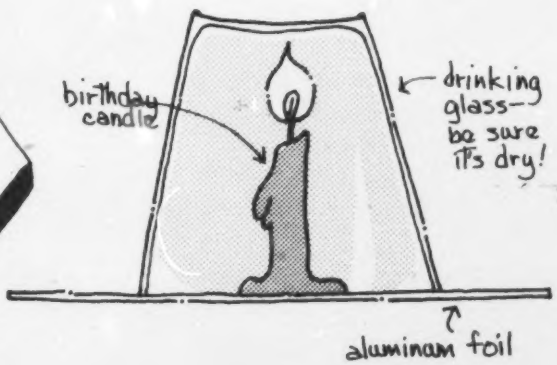
# HOW LONG WILL IT TAKE FOR A BIRTHDAY CANDLE TO USE UP THE OXYGEN IN A GLASS?

## MATERIALS:

paraffin is made from petroleum!

Birthday candle, drinking glass, watch
Aluminum foil, drinking straw
Lime or lime-water ← make lime-water by shaking 1 teaspoon of lime (ask a local garden shop) with 1 cup water. Let it stand until it becomes clear!

Set up your experiment like this:

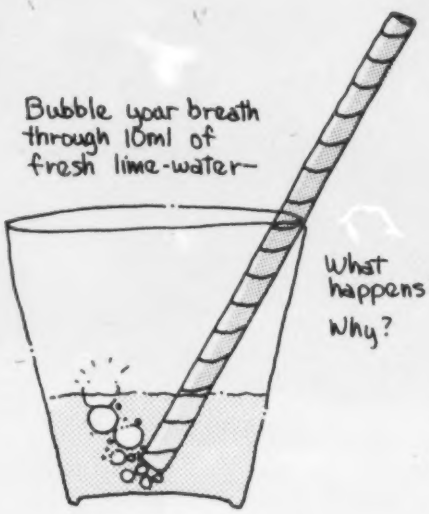



How long does it take for the candle to go out? What happens to the glass? Why?

Try this:

Add 10ml of lime-water to the glass and shake— if it gets milky it means the glass has carbon dioxide in it!

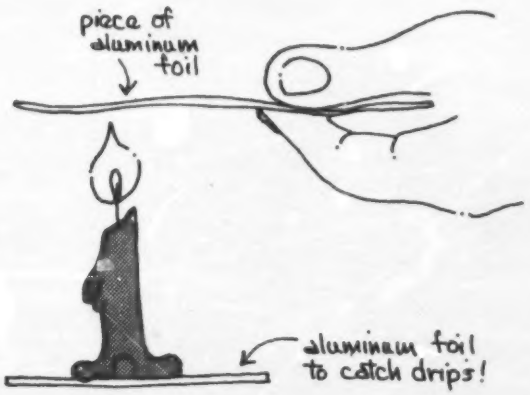
Then, try this:



## OTHER IDEAS TO EXPLORE:

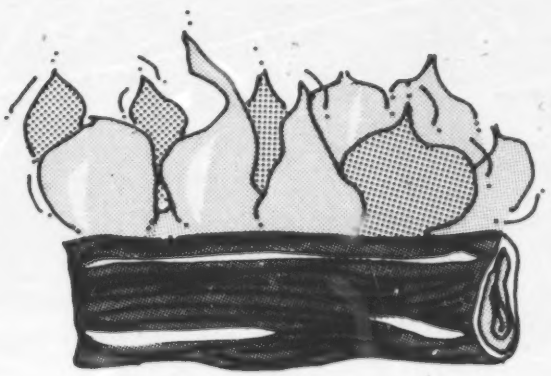
Relight the candle and hold some aluminum foil in the flame.

What collects on the foil above the candle?

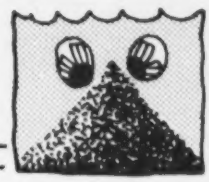


What pollutants are added to the atmosphere when large amounts of oils are burned for energy?

Can you set up an experiment to show that a piece of burning wood does the same thing as a burning candle?



# HOW DOES A MIXTURE OF ASHES AND WATER DIFFER FROM PLAIN WATER?



## MATERIALS:

2 Laxative pills (or more!) that have phenolphthalein (check the labels!) in them

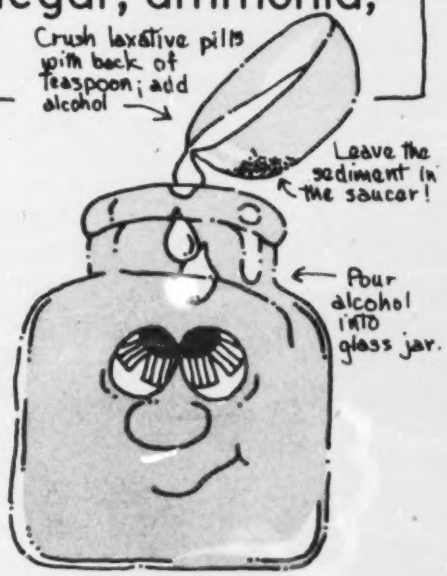
Ashes - fireplace, coal, charcoal, trash, etc. (Try scrap paper ashes!)

1/2 Cup rubbing alcohol, spoon, saucer

Glass jar with lid

White bar soap, baking soda, vinegar, ammonia; other materials to test

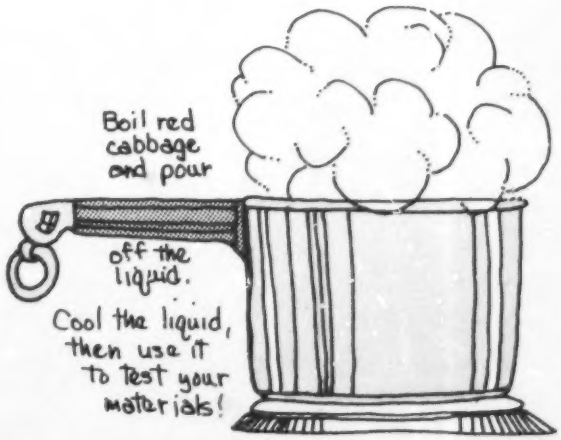
Do this first:



Test the soap and other materials by adding a drop or two of the alcohol solution. Record any color change.

Mix fireplace ashes with water and test with 1 or 2 drops of alcohol solution. Do the same with the other ashes, too. Which gives a stronger color change? (Try using ashes from other materials, too!)

# OTHER IDEAS TO EXPLORE:



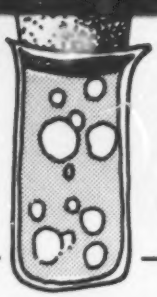

Make a testing solution with red cabbage and see what colors it produces in vinegar, baking soda, soap, etc.

Record the color changes and compare with the results of your earlier experiments.

Vinegar is an acid; see what color it becomes in your red cabbage solution. Test other materials; if they become the same color, they're acids, too.

Can you find something that changes the red cabbage solution to a different color?

# HOW MUCH METHANE ← natural gas! CAN YOU COLLECT IN 2 DAYS FROM 1/2 CUP OF COAL?

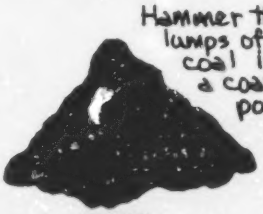


9

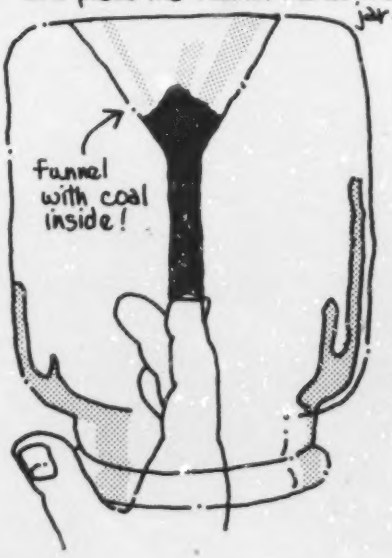
## MATERIALS:

Soft or bituminous coal
Funnel, quart jar, water
Test tube, rubber band

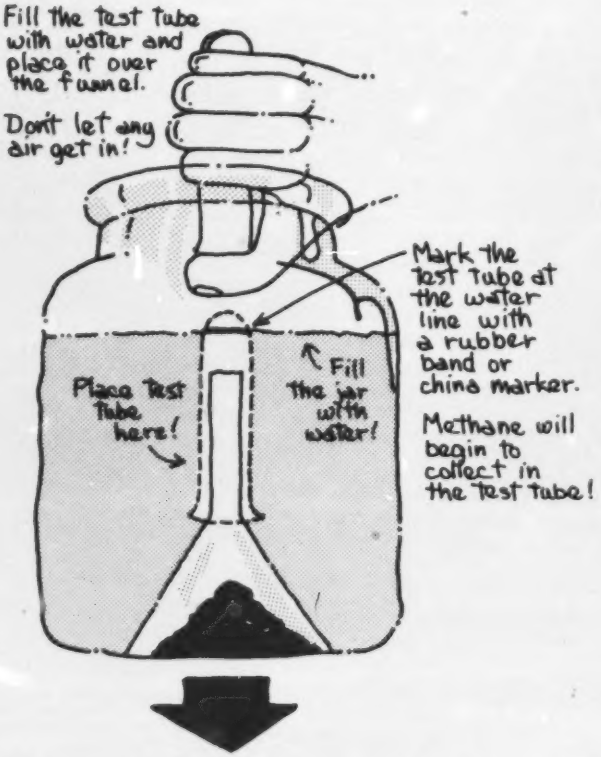
Do this first:




Put the coal in the funnel and place the funnel inside the jar.




Then, do this.

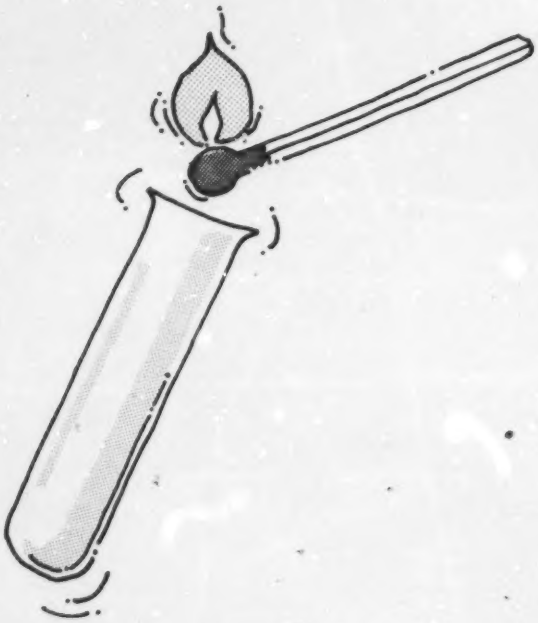

Fill the jar with water first.
Fill the test tube with water and place it over the funnel.
Don't let any air get in!
Mark the test tube at the water line with a rubber band or china marker.
Methane will begin to collect in the test tube!
Place test tube here!
Fill the jar with water!

this should take about 2 days!

After the tube seems to be filled, will the coal still give off methane gas? How can you find out?

## OTHER IDEAS TO EXPLORE:

Will the methane you collected burn?



Remove the test tube and put your thumb over the top.

Light a match and turn test tube upright. Let the gas out. What happens?

Why is mining a dangerous occupation?

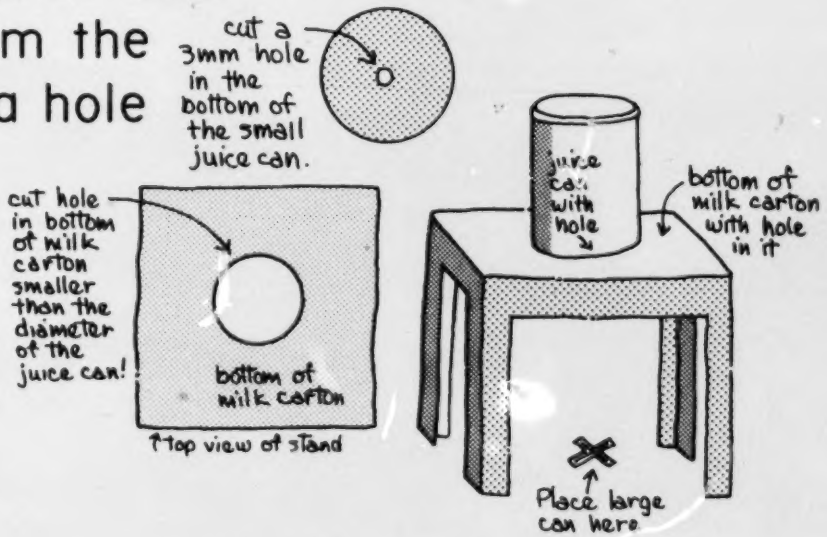
# WHICH FLOWS FASTEST: LIGHT OIL, HEAVY OIL, OR WATER?

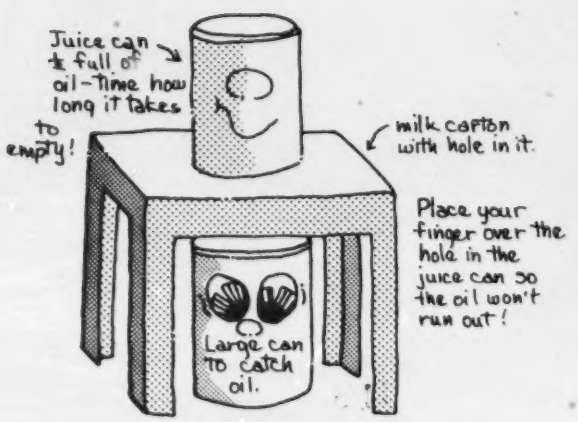
10

## MATERIALS:

Empty milk carton, scissors
Small tin can (like a juice can) and large tin can (larger than juice can)
#40 oil (heavy), #20 oil (light), and water
Watch with second hand

Put a hole in the juice can.
Make a stand from the milk carton. Cut a hole in it, too.

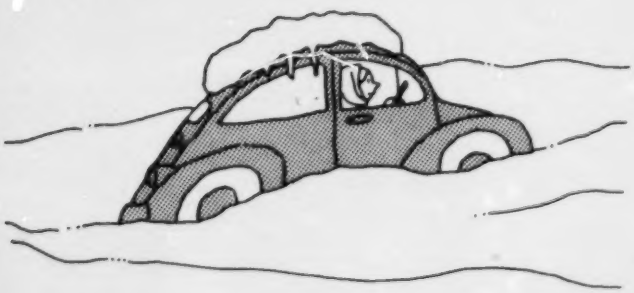

cut a 3mm hole in the bottom of the small juice can.
cut hole in bottom of milk carton smaller than the diameter of the juice can!
bottom of milk carton
Top view of stand
juice can with hole
bottom of milk carton with hole in it
Place large can here


Juice can ¼ full of oil - Time how long it takes to empty!
milk carton with hole in it.
Place your finger over the hole in the juice can so the oil won't run out!
Large can to catch oil.

Fill the juice can 1/2 full of heavy oil, and time it as it runs out. Clean the can. Repeat the experiment with light oil, then water. Compare the results!

# OTHER IDEAS TO EXPLORE:

Try this experiment again with oils and water after refrigerating them overnight!



Should we use heavy or light oil in the wintertime? How about the summertime?

# 11

# WHICH REDUCES FRICTION MORE: #40 OIL, #10 OIL, OR AN EDIBLE OIL?

## MATERIALS:

#40 Oil, #10 oil, edible oil, paper towels

All 4 blocks of wood should be the same size!

4 pieces of wood, 25 cm long x 8 cm wide and 2 cm thick - one side smooth, protractor

These 4 should all be the same size, too!

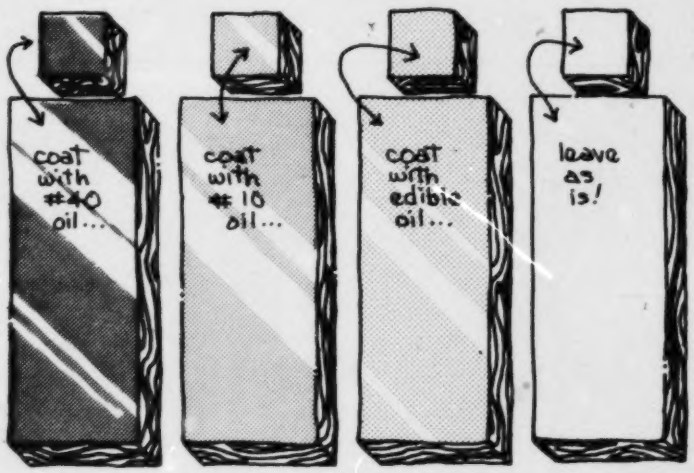
4 Blocks of wood, 6 cm x 6 cm x 4 cm (approx.) - edges should be saw-cut (not sanded!)

drawings not to scale...

Do this first:

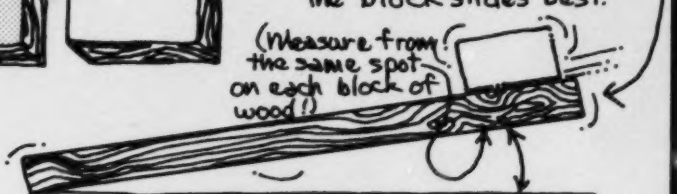
Coat 1 side of the boards and blocks with very thin layers of oil.

Rub them down with paper towels — don't leave any extra oil on them!




Raise the board to make an inclined plane. Drop the block gently onto the board at bigger and bigger angles until the block slides quickly downhill. Record the angle at which the block slides best.

(Measure from the same spot on each block of wood!)

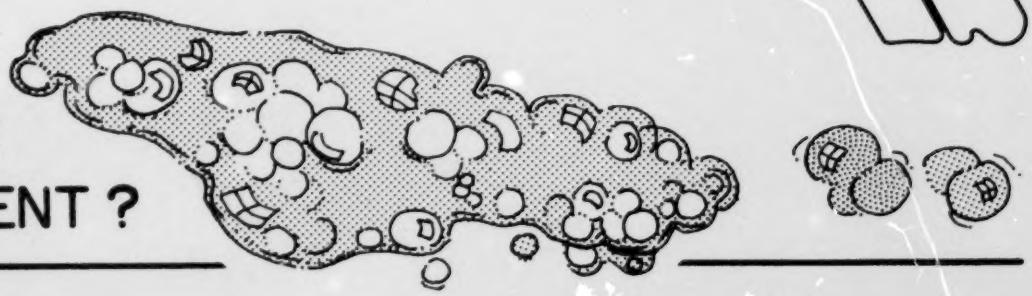


| Block | A | B | C | D |
|---|---|---|---|---|
| Type of oil | | | | |
| best angle | ° | ° | ° | ° |

Slide the blocks down the boards and record the angles. What happens?

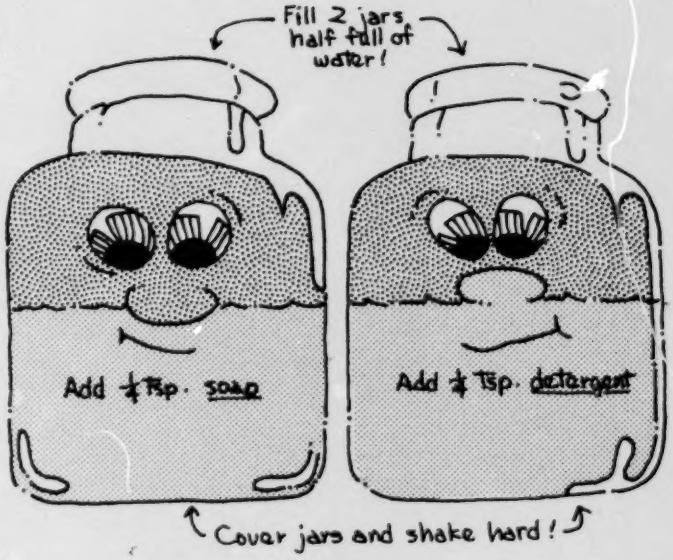
# WHICH PRODUCES MORE SUDS IN YOUR WATER, SOAP OR DETERGENT ?

12

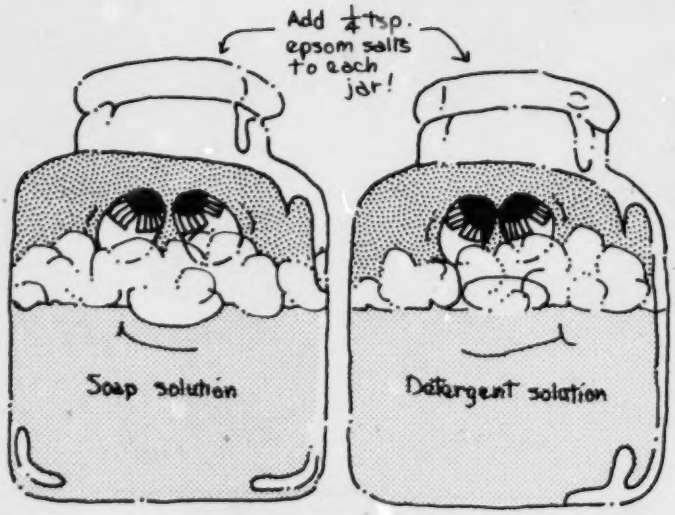


**MATERIALS:**

Soap powder, detergent powder, Epsom salts (magnesium sulfate), measuring spoons, small jars or test tubes (all the same size!)



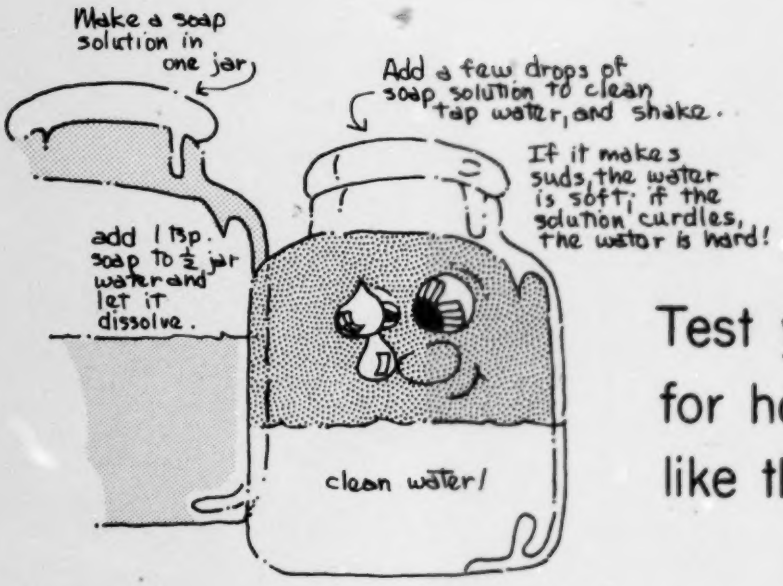

Which produces more suds?




Make the water "chemically hard" by adding Epsom salts to the jars. Cover and shake again. Now which is better ?

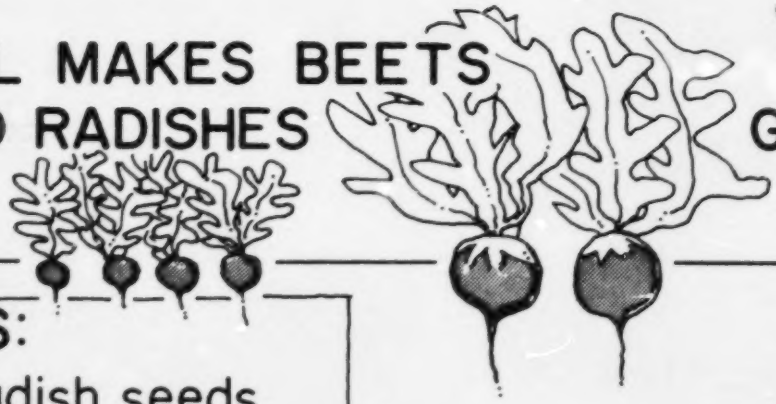
# OTHER IDEAS TO EXPLORE:

Do all detergents make the same amount of suds?


Make a soap solution in one jar.
Add a few drops of soap solution to clean tap water, and shake.
If it makes suds, the water is soft; if the solution curdles, the water is hard!
add 1 tsp. soap to ½ jar water and let it dissolve.
clean water!

Test your water for hardness like this.

# WHICH SOIL MAKES BEETS AND RADISHES GROW BEST?



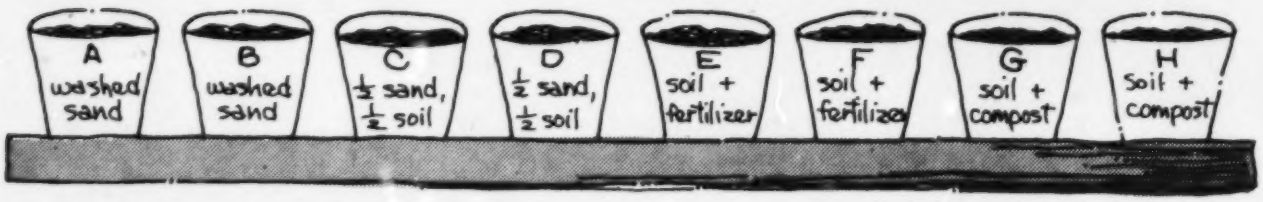
## MATERIALS:

- Beet and radish seeds
- Sand, soil, compost
- Timed-release fertilizer
- 8 Styrofoam cups

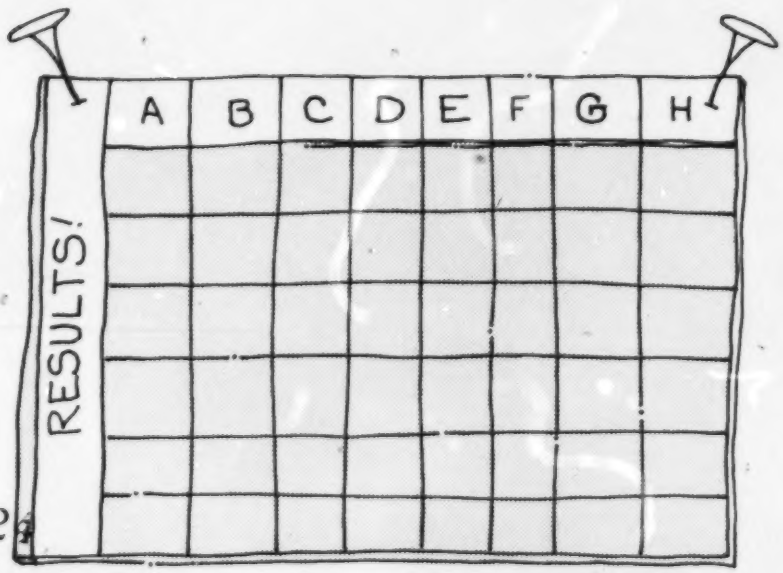
Follow the directions on the package!

Do this first:

Fill the cups with the potting mixes. Plant 2 beet or radish seeds in each.
Place them on a sunny windowsill and add 2 teaspoons of water to each cup daily!




Record your results. Which sprouts fastest? Which grows fastest?



## OTHER IDEAS TO EXPLORE:

Where does timed-release fertilizer come from?

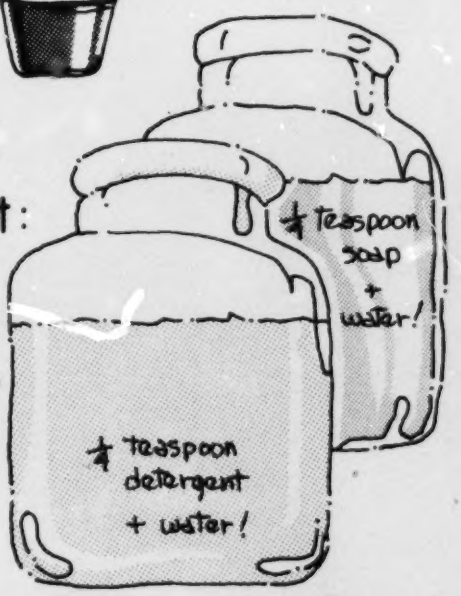
Which takes more energy to produce: compost or chemical fertilizer?

# ARE SMALL AMOUNTS OF SOAP OR DETERGENT HARMFUL TO THE GROWTH OF PLANTS?

**MATERIALS:**

- Radish or beet seeds
- Soap and detergent
- 3 Styrofoam cups
- Soil, water
- 2 Quart jars

Do this first:




Fill the jars to the same levels with water, and then make soap and detergent solutions!

Plant the seeds like this:

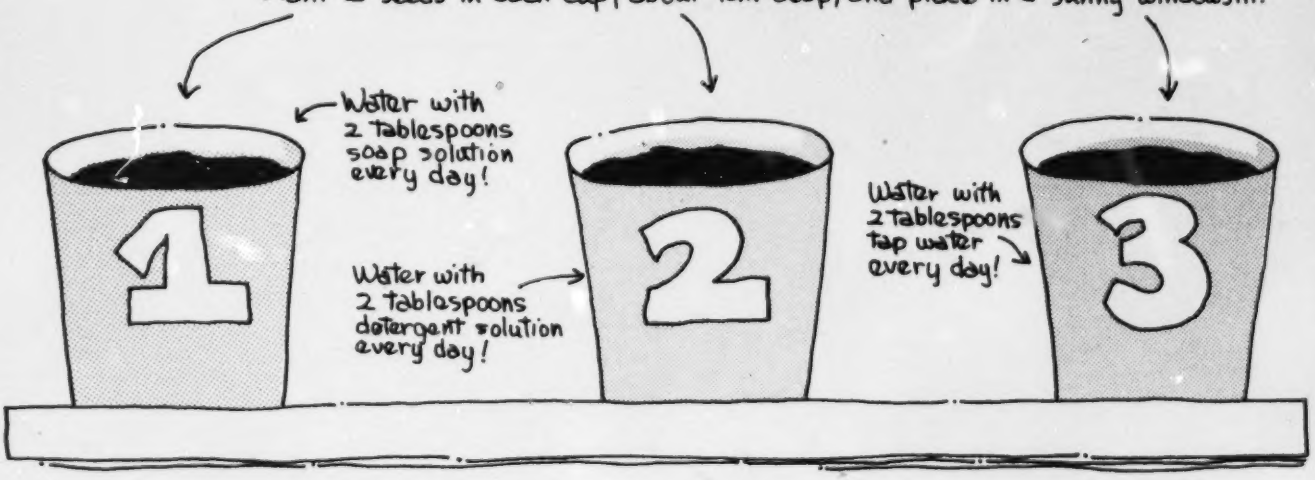

Plant 2 seeds in each cup, about 1cm deep, and place in a sunny windowsill.
Water with 2 tablespoons soap solution every day!
Water with 2 tablespoons detergent solution every day!
Water with 2 tablespoons tap water every day!
1
2
3

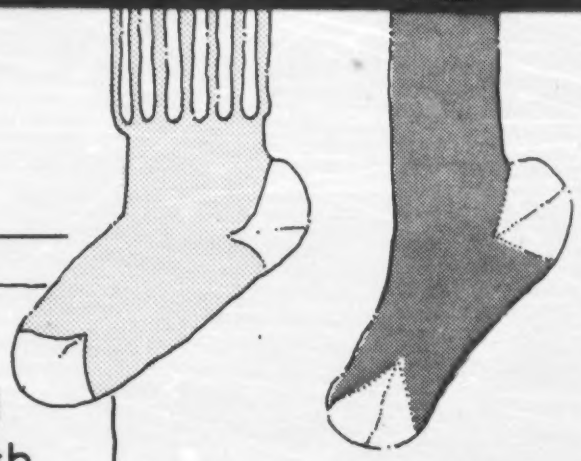
Chart the growth of each cup. Compare the results: Which sprouts first? Which grows fastest?

## OTHER IDEAS TO EXPLORE:

What happens to soap when it leaves your bathtub?

# WILL NYLON DISINTEGRATE AS FAST AS COTTON?

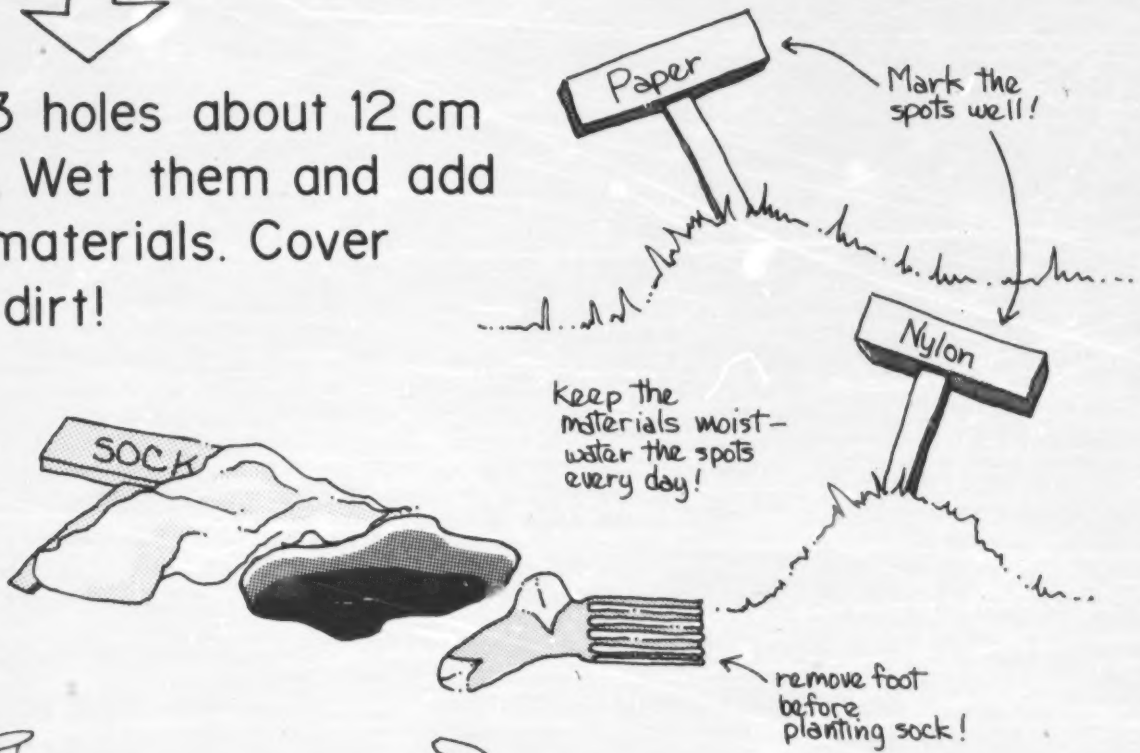
15

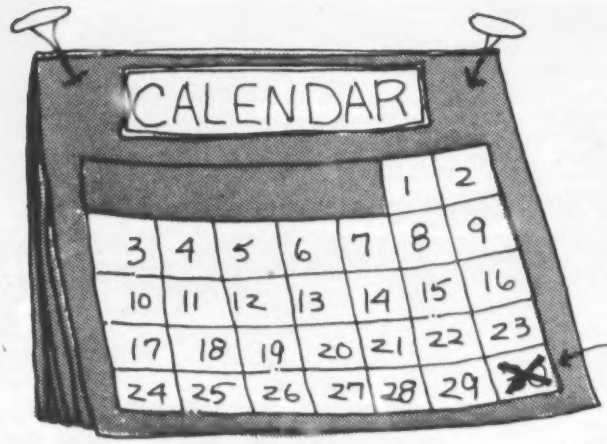


**MATERIALS:**

Old nylon stocking
Shovel, cotton cloth
Water, paper (like a Towel or sock)

Dig 3 holes about 12 cm deep. Wet them and add the materials. Cover with dirt!

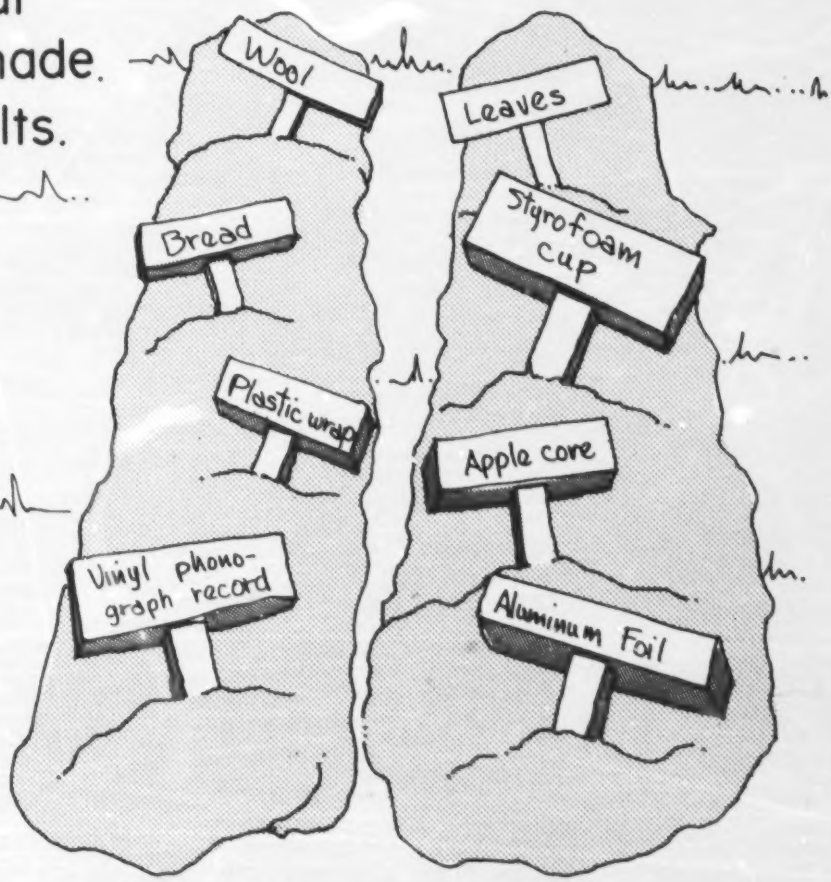


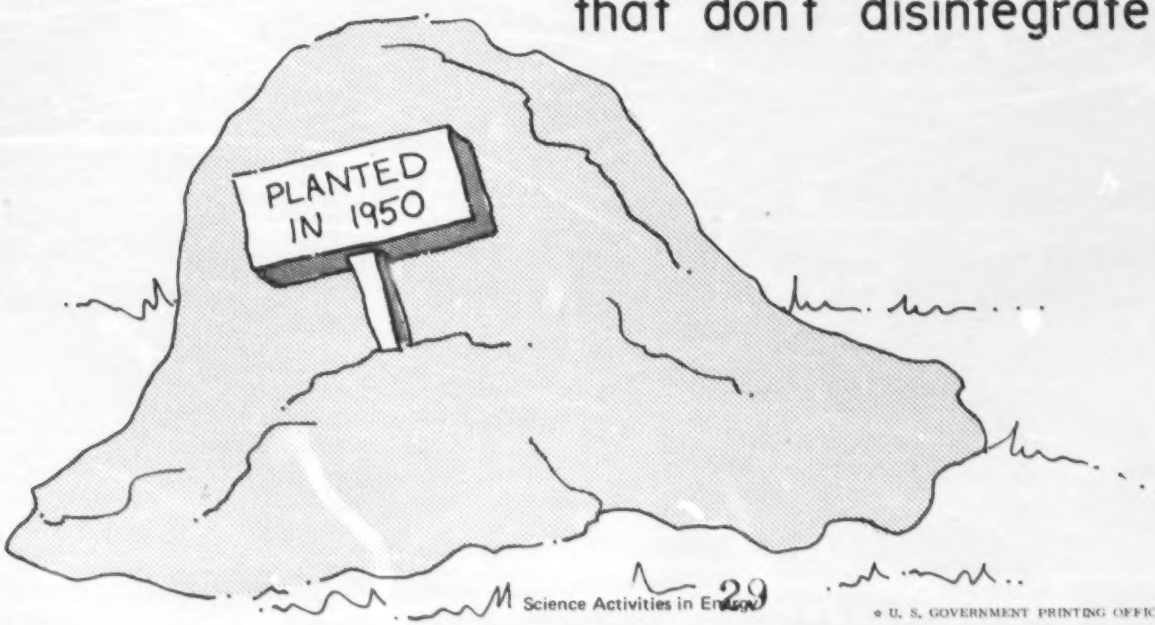

Dig everything up in 30 days. What changes took place?

# OTHER IDEAS TO EXPLORE:

"Plant" many other things, both natural as well as man-made. Compare the results.




What happens to things that don't disintegrate?






* U. S. GOVERNMENT PRINTING OFFICE : 1977 O - 246-902

**1. How long does a cell made from magnesium and brass light a lamp?**

Chemicals can be converted into electricity but the cost is very high. Such conversion is useful only where small amounts of electricity are required—as in portable transistor radios.

**2. How much electricity do you get back when you store it in your storage cell?**

Even if it becomes practical to generate electricity by using the sun and the wind, it will still be necessary to store the solar or wind energy when the sun or wind are absent. One possible way of doing this is to convert the electricity to chemicals and then reverse the process when needed. Present batteries are exceedingly heavy and not too efficient.

**3. Which has more heat energy, a peanut or a walnut?**

Almost all energy comes from the sun. All food has varying degrees of energy which we use in our bodies for heat and motion. By eating and digesting food we are using the energy of the sun.

**4. How rapidly does a plant make starch?**

The basic product of photosynthesis is sugar which is immediately transformed into other products such as starch and protein.

**5. How long do you have to expose blueprint paper to make a picture?**

Important chemical reactions can be triggered by the ultraviolet rays of the sun. Reactions such as the one demonstrated in this experiment may ultimately lead to improved means of capturing the power of the sun.

**6. Which has more energy: wood or paraffin?**

Both wood and petroleum burn, but because petroleum is a very concentrated source of energy it has much more heat value.

**7. How long will it take for a birthday candle to use up the oxygen in a glass?**

All fossil fuels use oxygen when burned and produce carbon dioxide and water. They also produce carbon, carbon monoxide, and oxides of sulfur, which can add dangerous pollutants to the atmosphere.

**8. How does a mixture of ashes and water differ from plain water?**

One of the problems with burning wood and coal is disposing of their ashes. This test is for alkalinity, and shows one of the chemical properties of ash.

**9. How much methane can you collect in two days from 1/2 cup of coal?**

The mining of coal is a hazardous occupation because many mines have high concentrations of methane gas. The prospect of increased use of coal to satisfy energy needs highlights the seriousness of this problem.

**10. Which flows fastest: light oil, heavy oil, or water?**

The viscosity or ease with which a liquid flows is important in predicting how useful it is in protecting cold engines from wear. The value of oil as a lubricant cannot be overestimated.

**11. Which reduces friction more: a number 40 oil, a number 10 oil, or an edible oil?**

The lubricating properties of oil are as important as oil's value as a fuel.

**12. Which produces more suds in your water, soap or detergent?**

Detergents, which are chemicals made from petroleum, are more efficient cleansing agents than soap, especially in hard water. Some scientists think oil is too valuable to be burned as fuel and should be reserved to manufacture synthetic materials such as detergents, plastics, etc.

**13. Which soil makes beets and radishes grow best?**

Most soils require fertilizer to maintain their ability to grow food and fiber. A great deal of oil and gas is required to make chemical fertilizer. Compost is nature's way of recycling minerals.

**14. Are small amounts of soap or detergent harmful to the growth of plants?**

The extent of the detrimental effects on the environment of many synthetic materials derived from fossil fuels requires intensive and extensive study.

**15. Will nylon disintegrate as fast as cotton?**

A major problem with some synthetic material—nylon, for example—is what to do with it when it is no longer useful.